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Benefit/Cost Analysis for State and Local Noise Control Programs, Phase II Report: In-Use Controls of Motor Vehicles with Degraded Mufflers and Regulations Scenerios

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BENEFIT/COST ANALYSIS FOR STATE & LOCAL NOISE CONTROL PROGRAMS PHASE II REPORT: In-Use Controls of Motor Vehicles with Degraded Mufflers and Regulations Scenerios

JUNE 1981

U. S. ENVIRONMENTAL PROTECTION AGENCY
Office of Noise Abatement and Control
Washington, D. C. 20460

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16. ABSTRACT

This study projects the noise exposure of the U.S. population from motor vehicles to the Year 2000 and indicates the reduction of such exposures from various new product regulations compared with in-use enforcement programs that concentrate on the removal of a portion of defective motor vehicle exhausts. Along with the benefits, the potential costs of various controls are projected for comparison purposes.

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FOR

STATE AND LOCAL NOISE CONTROL PROGRAMS

Phase II Report: In-Use Controls of Motor Vehicles with Degraded Mufflers and Regulations Scenarios

U.S. Environmental Protection Agency
Office of Noise Abatement and Control

June, 1981

Dr. Paul U. Pawlik
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FOREWORD

This paper is a continuation of a paper entitled, "Benefit Analysis for State and Local Noise Control Programs: Phase I Report: In-Use Control of Motor Vehicles with Degraded Mufflers."

Like the Phase I report, it analyzes the effectiveness of State and local noise controls directed toward noisy exhausts and compares the results with those expected from the planned and promulgated regulations. Unlike the Phase I report, other regulatory scenarios are examined. In addition, spillover benefits from local programs are analyzed by themselves and in conjunction with regulatory benefits. Then costs of major noise control options and combinations are estimated and analyzed.

These additions to the Phase I report should not be construed as final changes because those new sections should be refined further as more data become available in the future.

I. OVERVIEW

More people are exposed to environmental noise from surface transportation than from any other source. In fact, surface transportation sources dominate the cumulative dose of environmental noise for far more people than other sources, as well as contribute greatly to the intrusive noise that impacts people, especially in their homes.

There are a number of actions that people can take to reduce their noise impact if such a problem exists in their neighborhood. These could include insulating the house to reduce noise intrusion through the walls, installation of storm windows, relocation of bedrooms to the quieter side of the house, and avoiding outside activities during high noise periods. However, the amount of noise reduction that can be achieved without incurring enormous costs by people who live near freeways or other major highway systems is quite limited. In some instances, moving to a quieter neighborhood is the least costly solution.

Some additional relief can be obtained in high noise impact areas through in-use vehicle noise standards, construction of roadside noise barriers, time of day use restrictions, the establishment of quiet zones, and new product regulations. Most of these methods require some sort of Government involvement.

Unfortunately, detailed analysis of the relative effectiveness of many noise control methods has been inhibited because of the lack of adequate data, especially those data referring to only the effectiveness of local control actions. Recently some information on the effectiveness of State and local enforcement programs addressing loud exhausts has been generated. With help of this information national noise reduction benefits are projected and compared to those derived from new product regulations. In addition the relative costs of major types of programs are assessed and compared. This project is being undertaken primarily to elaborate upon the national implications of various

programs. Locally, exhaust noise enforcement programs over a period of time may reduce the incidence of annoyance as well as the number of people exposed to high environmental noise levels. The national problem is further reduced as quieted vehicles are operated outside of jurisdictions with enforcement programs, and when such programs are supplemented by quieter regulated vehicles.

A. RELATIVE IMPORTANCE OF IN-USE CONTROLS DIRECTED TOWARD NOISY EXHAUSTS

Effective state and local noise control programs are a necessary part of the national noise control effort because they can address local noise programs expeditiously and independently of actions in other jurisdictions or on the national level. There are no mandatory federal requirements for states or localities to create noise control programs as there are in many other environmental and health-related areas. While new promulgated and planned product standards for major sources of noise (such as medium and heavy trucks and motorcycles and buses) are projected to be effective in terms of reducing the rise in environmental noise exposures from vehicular traffic, the potential benefits of new product noise reductions will never be fully achieved if these sources are allowed to become significantly noisier while in use. For this reason, among others, it is particularly important to have a number of active state and local programs aggressively discouraging the operation of noisy vehicles. Due to the localized nature of noise pollution problems, each state or community may choose to control the noise problems particular to its locality by using a method most appropriate to the surrounding circumstances. Some alternatives include non-preempted new product standards, operational curfews, designation of quiet zones, imposition of lower speed limits, specific property line noise standards,

and a host of others. Given the broad latitude of authority available at the state and local level, it appears that most noise problems can be effectively addressed by these jurisdictions.

As the network of communities with programs grows, the projected benefits will grow exponentially. This non-linear phenomenon occurs because of so-called "spillover" benefits. For example, if several communities in one area have enforced ordinances dealing with defective exhaust systems, there will be beneficial spillovers to others for two principal reasons: (1) properly maintained vehicles from the community with the noise program are likely to leave the community at one time or another and cause less noise pollution in other areas, and (2) vehicles from areas without noise programs will be required to conform to the levels prescribed by the jurisdictions with enforced ordinances. A case in point is San Francisco. Thousands of suburbanites commute daily into the city every day. Many come from jurisdictions without vehicular noise programs. When in San Francisco, they have to comply to the noise ordinance. When they are in compliance they drive the same vehicle home, even if the home jurisdiction has no noise program. This gives relief to people along the commuting route as well as to those in the home town. Often, after the word spreads in a jurisdiction with a program, the major enforcement efforts have to be directed to such "foreign" vehicles. In San Francisco, for example, most of the local vehicles have been brought into compliance. Most vehicles stopped now are "foreign."

For this reason, a network of local programs is more effective than isolated States and communities with noise control programs. EPA believes that noise control programs in approximately 400 communities of greater than 25,000 people each, represents a network with significant spillovers benefits. Since more people are exposed to environmental noise emanating from surface transportation

than from any other noise source, EPA believes that at least 350 of these community programs should include a motor vehicle control component. As of October 1, 1980 there were approximately 160 active local programs with motor vehicle components in cities of over 25,000 population.

To qualify as an "active" noise control program a community must have an ordinance or the equivalent in effect that includes controls for either: motor vehicles, stationary source/property line controls, construction noise, or a program for prevention of future noise problems. The community must further demonstrate its commitment to a continuing noise program effort through allocation of personnel, funds, and appropriate equipment. It must also have an ongoing enforcement program and public information service available to its citizens.

In practice this is a fairly strict set of requirements for defining an active program. Many communities involved in noise control work today would not qualify under this criteria. The basis for establishing these requirements allows, for the purposes of assessing the health and welfare benefits of state and local noise control, an assumption that an active program is an effective one. To carefully document and prove this relationship for each location would be costly and time consuming on a national basis. Rather, requirements have been established that identify, on a more or less summary basis, communities that would be expected to have effective noise control programs. However, the specific framework of each noise control program is left to the particular local jurisdiction.

Most communities will probably choose to do something to solve the exhaust noise problem. Local programs dealing with defective exhaust systems can be put in place quickly and tailored to specific community needs. These programs

do benefit communities, and make a measurable national impact. Even though in the long run they are not as effective by themselves as new product standards directed toward medium and heavy trucks, they are essential in addressing major citizen complaints. When in-use enforcement programs are combined with new product standards, the combined benefits are even more significant than the standards alone.

B. RELATIVE IMPORTANCE OF NEW PRODUCT REGULATIONS

In comparison with in-use controls directed primarily against noisy exhausts, new product regulations of trucks were found to be more effective in reducing "national" noise exposure reductions. The results of various regulatory scenerios indicated that the resulting noise exposure reductions are more significant, nationally, because the basic vehicles will be less noisy, compared to dwelling only on the maintenance of noise attenuating equipment. It takes many years to replace the truck fleet with quieter models, however, and after the fleet levels are reduced, in time the number of people exposed to various noise levels will increase again, primarily because:

(1) trucks do deteriorate over time;
(2) the truck fleet is expected to grow; and
(3) the population is expected to grow

C. COSTS OF MAJOR PROGRAMS

Costs were defined as the additional expenses borne by a manufacturer in complying with a regulation and "gross" enforcement cost for localities with noise programs. (Gross costs exclude the collection of fees for violations. Under certain circumstances the net program costs, i.e., gross costs less fines can be zero or negative).

There is a range of costs in enforcing against defective exhausts, depending on the type of program. Essentially, a noise team can be assigned to devote full time to noise problems, or noise codes can be enforced along with other things like traffic speeds or directing traffic. The range of program costs on the annual basis between 1980 and 2000 is below the cost of regulating vehicles, per the various scenerios. As mentioned earlier, so are the benefits. An absolute benefit/cost rate will not be established, because there is a wide range of enforcement possiblities and because the data base linking a particular program's payoff with costs is not adequate. A detailed cost discussion will follow in Section IV.

II. NOISE EXPOSURE CHANGES: BASELINE AND RESULTS FROM REGULATION SCENARIOS

A. THE NATIONAL ROADWAY TRAFFIC NOISE EXPOSURE MODEL (NRTNEM)

The National Roadway Traffic Noise Exposure Model (NRTNEM) structure and data components were used to assess the noise exposure reduction in response to various new product regulation scenerios and local enforcement programs directed toward noisy exhaust systems.

Population Data

The model uses a baseline population for 1974 of 216.7 million people. There are 152.52 million people who are categorized as residing within eight urban place size classes and 64.18 million people categorized as living in rural areas with an assumed uniform population density. The eight urban place sizes are each further subdivided into four population density categories. Using Federal Highway Administration (FHWA) data, the population was allocated to appropriate roadway traffic conditions. The FHWA data base was further divided according to a functional roadway classification which incorporates the average population density adjacent to the roadway, the average travel speed by population place size, and the distribution of roadway mileage and travel.

Roadway and Traffic Data

The roadway mileage, configuration, and travel data is structured around a functional roadway classification. The basis for this classification is the type of service performed by the roadway. The two basic characteristics of this roadway service are:

- o Degree of vehicular access to adjoining land uses
- o Ease of vehicle passage.

Six classes of roadway types are utilized in the model:

- o Interstate
- o Highways
- o Major arterials
- o Minor arterials
- o Collectors
- o Local streets

The nation's 3.586 million miles of roads are allocated according to this roadway classification and population place size. The quantity of Daily Vehicle Miles Traveled (DVMT) for each roadway type and population place size was also extracted from FHWA data. The Average Daily Traffic (ADT) is estimated by dividing the DVMT by the number of roadway miles per category.

Further growth in ADT is assumed to be proportional to the growth in the vehicle population and distributed uniformly across all roadway types. Average travel speed is also assumed to remain constant despite increasing ADT over time.

The distribution of vehicle fleet mix by roadway type, place size and vehicle type is defined in the NRTNEM data base. A base year distribution for 1974 is already established as part of the model. The model adjusts this mix in future years based upon the sales forecast for each vehicle type for a particular future year. Roadway configurations are assumed to be homogeneous among types of raodways with a uniform 12 foot lane width.

Vehicle operating characteristics are defined by the percent of time each vehicle type is operating on a roadway type in a particular mode. There are four operational modes:

- o Acceleration from idle
- o Deceleration from cruise
- o Cruise
- o Idle

Vehicle Data

There are four overall categories of vehicles included in NRTNEM. These four categories are:

- o Light vehicles (passenger cars and light trucks)
- o Trucks (medium and heavy)
- o Buses (intercity, transit and school buses)
- o Motorcycles (unmodified and modified).

These overall categories are further subdivided along specific design characteristics into fourteen classes. The distribution of vehicle types, and survival patterns are derived from historical data.

Normally NRTNEM will incrementally implement a new product standard via the sales growth of new vehicles and the attrition of old vehicles over time. In this case it is assumed that state and local motor vehicle control programs when implemented with an enforcement program will have an immediate noise reduction impact. In order to implement this effect with NRTNEM, inputs were translated into equivalents specified by the model, rather than changing the construct of the model.

In addition it must be noted that the NRTNEM makes a number of simplifying assumptions to permit the computation of cumulative exposures on a nationwide basis:

- o Traffic is uniformly distributed over all vehicle lanes.
- o Cruise speed is the same for all vehicle lanes for any given segment of roadway.

- o Headway (i.e., vehicle spacing) is constant.
- o Roadways appear infinitely straight relative to the receiver.
- o Daily traffic flow is constant (including weekends).
- o Daytime (7 am to 10 pm) traffic always constitutes 87 percent of the total traffic flow.

Sound Propagation

The propagation of the roadway noise entails the final link in the calculation of the noise exposure to the population. The Generalized Adverse portion of NRTNEM uses different line source attenuation functions for high, medium, and low density population areas. The distance from the roadway to the nearest receptors is defined by a matrix of "clear zones" as a function of roadway type and city size. The noise exposure from secondary roadways upon a receptor is also considered.

The output of the General Adverse Response portion of the NRTNEM is numbers of people and level-weighted people (LWP) exposure to roadway noise above a day-night level of 55 dB for both the current or baseline period and future periods.

B. COMPARING REGULATIONS AND ENFORCEMENT BENEFITS

In order to assess the benefits from State and local muffler exhaust system enforcement programs, it is necessary to establish a basis for comparison. Therefore, various types of surface transportation noise control options were simulated on the National Roadway Traffic Noise Exposure Model (NRTNEM).

The first step to assess benefits for any purpose is to establish a baseline. In this case, the baseline used is how many people would be exposed to various noise levels from surface transportation sources if there were not noise control programs, either regulatory or State and local muffler enforcement. In this case, since the number of vehicles and the number of people will grow between now and the Year 2000, the noise levels would also grow significantly. This, in effect, means that the number of people exposed to the noise will also increase.

After establishing the baseline exposure level, various regulatory options were examined. For comparison purposes, the NRTNEM was used to estimate how many people would be exposed to various noise levels if any current Federal regulations plus all previously proposed regulations were in place.

It should be noted here that unlike the analysis previously used for regulations, the options used for this report assume that a proportion of vehicles are operating with defective mufflers. Therefore, impact estimates for pre-regulatory exposures are higher than those previously calculated.

Noise exposure changes were also estimated for a medium and heavy truck regulation (MHT) not to exceed 83 dB (effective 1978), and for a 75 dB MHT effective 1980, given the original MHT regulation was promulgated as scheduled and the bus regulation and motorcycle regulation were promulgated as per Exhibit I-1.

The noise exposure change in response to exhaust noise enforcements on the local level were calculated by inserting into the NRTNEM noise emission changes and fleet coverage for motorcycles, buses and medium and heavy trucks that are expected to result from an enforcement program directed against loud exhausts. The results were than rated to reflect the partial coverage of the universe of communities with populations larger than 25,000.

EXHIBIT I-1
CURRENT* AND PREVIOUSLY PROPOSED FEDERAL NOISE CONTROL REGULATIONS

Current Regulation

Vehicle Type	Not-to-Exceed Noise Level	Effective Date
Interstate Motor Carriers over 10,000 Pounds GVWR	Stationary pump 88 dB Under 35 mph 86 dB Over 35 mph 90 dB	October 15, 1975
Medium and Heavy Trucks	83 dB 80 dB	January 1, 1978 January 1, 1983
Street Motorcycles	83 dB 80 dB	January 1, 1983 January 1, 1986
Moped Type Street Motorcycles	70 dB	January 1, 1983
Off-Road Motorcycles		
a. Displacement 170cc and below	83 dB 80 dB	January 1, 1983 January 1, 1986
b. Displacement more than 170cc	86 dB 82 dB	January 1, 1983 January 1, 1986

Proposed Regulations

Vehicle	Not-to-Exceed Noise Emission Levels (dB) exterior	interior	Effective Date
All buses (except school buses, cowl chassis, and buses incorporating cowl chassis	83 80 77	86 83 80	September 1, 1981 September 1, 1985 September 1, 1987
School buses, cowl chassis and buses incorporating cowl	83 80 (reserved)	86 83 (reserved)	September 1, 1981 September 1, 1985 September 1, 1987

*As of January 10, 1981

C. BASELINE AND REGULATORY SCENERIOS

Baseline Scenerio

Results generated from the National Roadway Traffic Noise Exposure Model (NRTNEM) indicate that without Federal, State and local noise programs, the number of people exposed to various levels of environmental noise originating with motor vehicles will increase steadily in the future. Exhibit II-1 indicates that the projected number of people exposed to Ldn greater than 75 dB will more than double between now and Year 2000, while the number of people exposed to Ldn greater than 55 dB will increase approximately 50%.

Regulatory Scenerios

If the Federal government were to promulgate the bus regulation and motorcycle regulation as planned prior to November 1, 1980 and, proceed to implement the medium and heavy truck regulation as promulgated, the number of people exposed to Ldn 55 dB and 75 dB would be reduced significantly below the normally expected levels. By Year 2000, the expected increase for Ldn 75 dB would, for all practical purposes, be eliminated. For Ldn 55 dB only a nominal growth would occur (See Exhibit II-2).

If the second phase of the medium and heavy truck regulation were not implemented at all, i.e., the 83 dB medium and heavy truck (MHT) regulation effective in 1978 would not be followed by stricter levels, noise exposure growth would likewise be significantly curtailed but not as much as if the second phase of the MHT regulation were to become effective. Exhibit II-2 demonstrates that the 83 dB MHT regulation by itself would hold Year 2000 noise exposures to slightly above the 1980 levels.

Exhibit II-I

Projected Exposures to L_{dn} 75 dB and 55 dB, Assuming No Federal and State and Local Programs

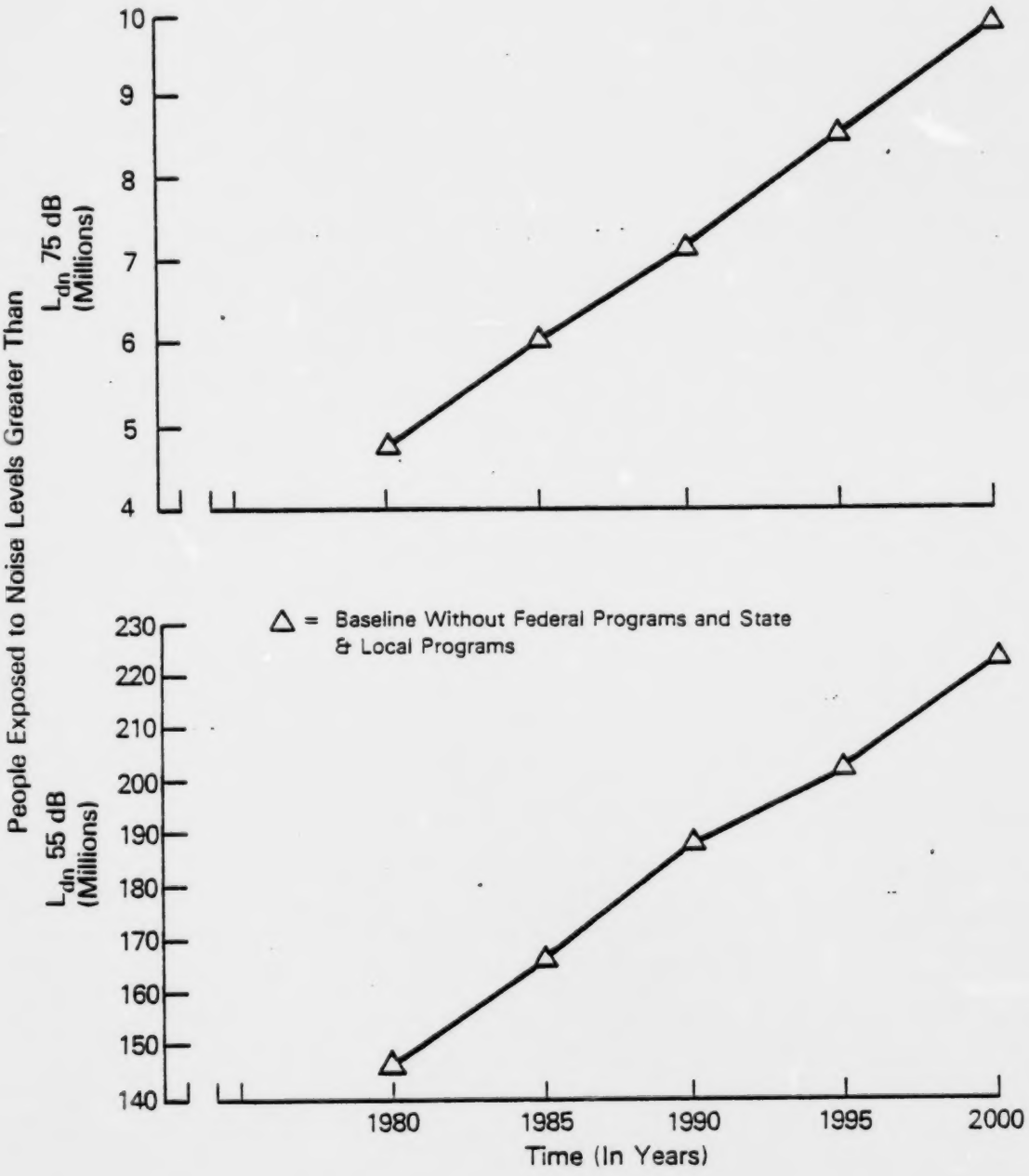
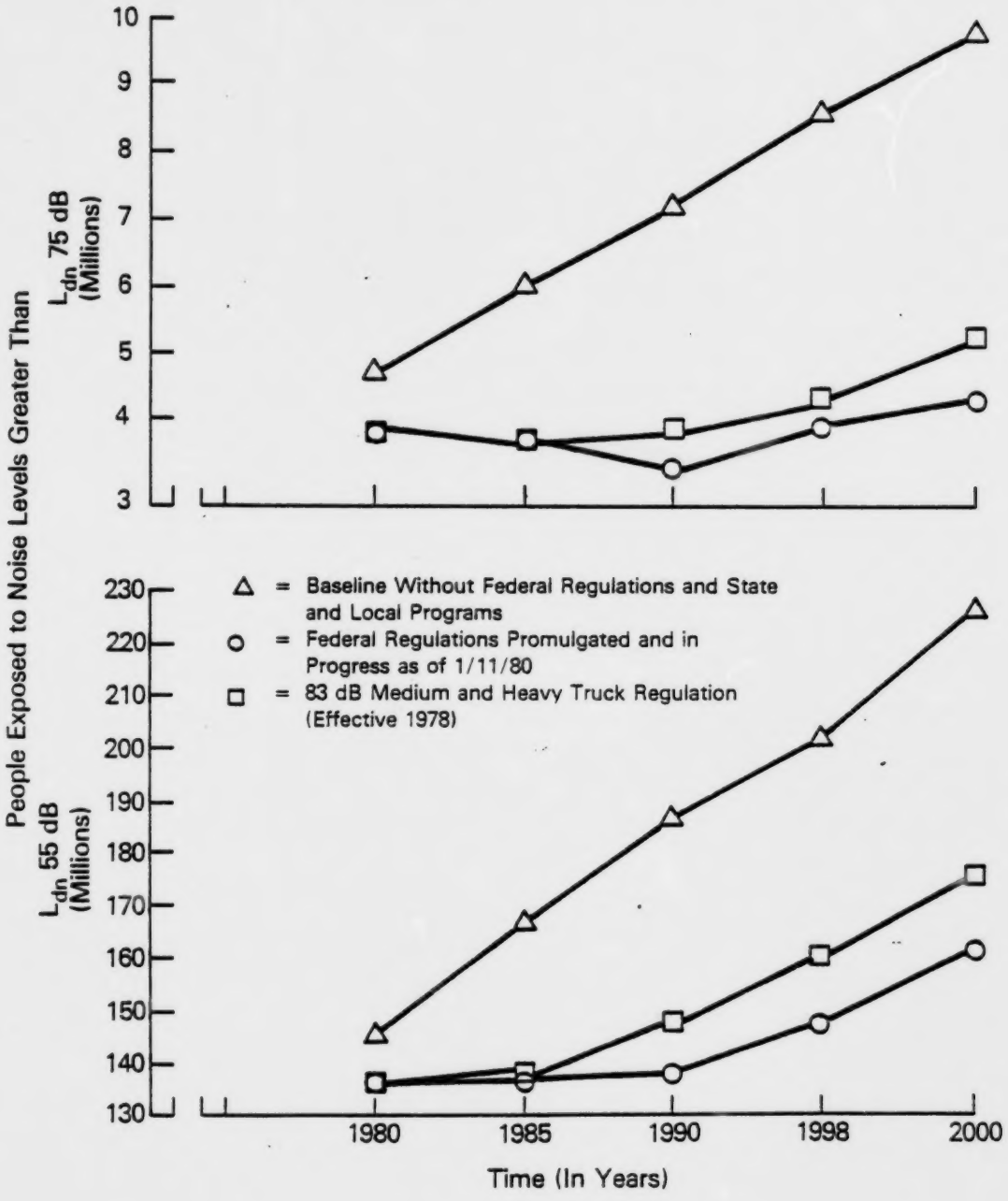


Exhibit II-2
Projected Exposures to L_{dn} Greater Than 75 dB and 55 dB, Assuming Various Federal Regulatory Scenerios



While the noise reduction achievements related to regulations are significant, they nevertheless do not meet EPA's goal to reduce envionmental noise exposure to an Ldn value of no more than 75 dB immediately. The regulations do, however, help approach another EPA goal, namely to strive for an eventual reduction of noise levels to an Ldn of 55 dB.

III. EXPOSURE IMPACT FROM LOCAL ANTI-EXHAUST NOISE ENFORCEMENT PROGRAMS

A. ENFORCEMENT BENEFITS WITHOUT REGULATIONS

Local enforcement programs directed primarily toward noisy exhausts cannot be expected to have as large a noise exposure reduction impact as new product regulations, because they do not, in most cases, reduce the noise level of new products. They merely serve to assure that a large portion of the vehicle fleet is not operated with defective exhausts. Nevertheless, measurable effects are obtained from active enforcement programs. Exhibit III-1 indicates that as the number of communities with enforcement programs is increased from present communities with programs (about 160) to 350 communities, so will the benefits. Additional benefits can be assumed to result from spillovers. It is very likely that for every two persons covered by an active program, one person will be incidentally affected. In some areas it will be more, in others less. In a city like San Francisco where many commuters enter the city daily from communities not covered by active programs, the number is expected to be higher than in somewhat isolated communities.

B. BENEFITS FROM COMBINING ENFORCEMENT WITH REGULATIONS

Regulations and enforcement programs are mutually reinforcing. Achievements attained by a regulation can be enhanced with actively enforcing anti-noise exhaust codes. Obviously, the more communities in the active network and the larger the benefit spillovers, the larger the exposure reductions are expected to be attained above and beyond those attained from

Exhibit III-I

Projected Exposures to L_{dn} Greater than 75 dB and 55 dB, Assuming Various Levels of State and Local Programs Without Federal Regulations

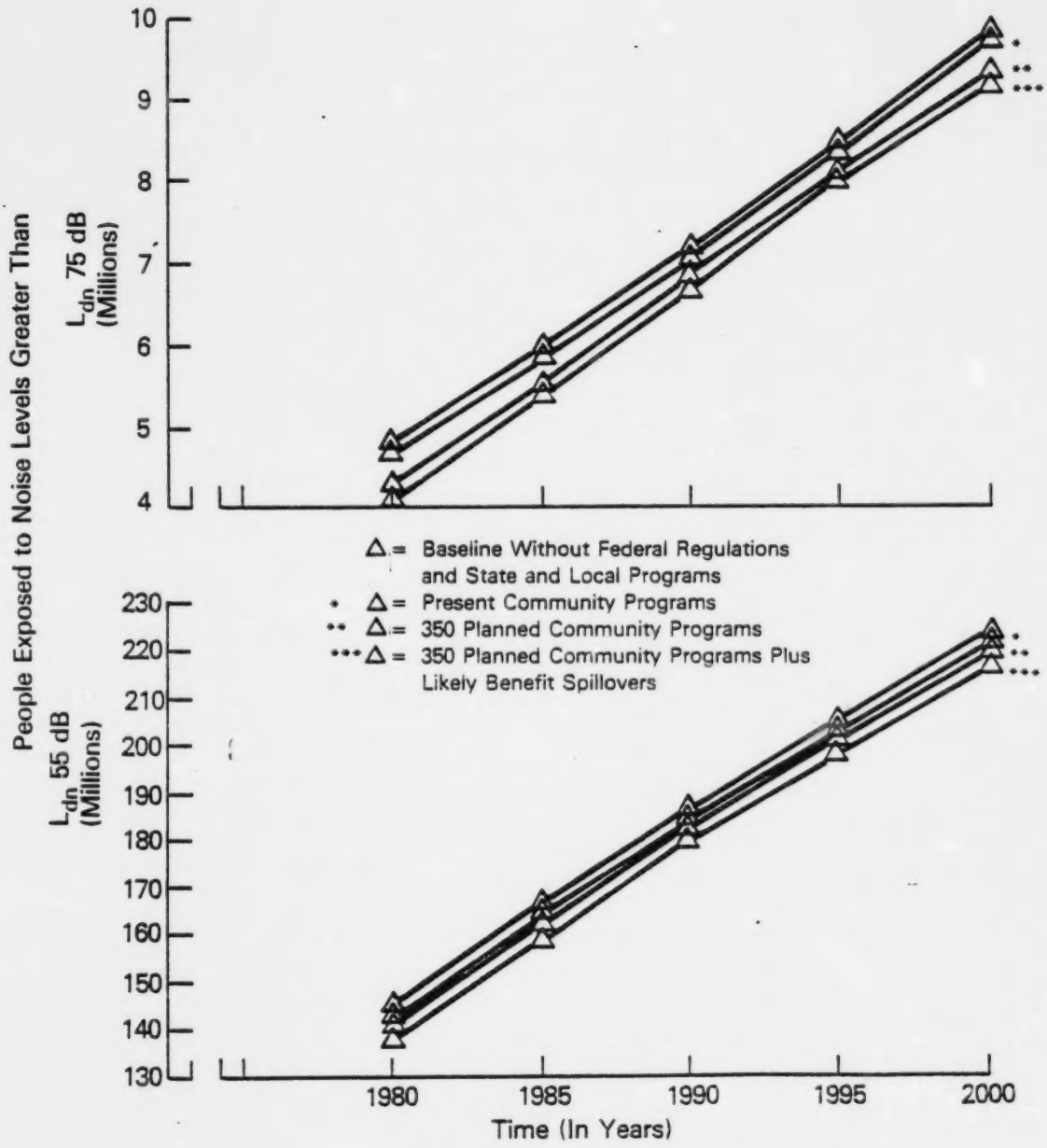


Exhibit III-2
Projected Exposures to L_{dn} Greater Than 75 dB and 55 dB, Assuming Federal Regulations as Promulgated and Planned (CFR) Together with Various State and Local Enforcement Scenarios

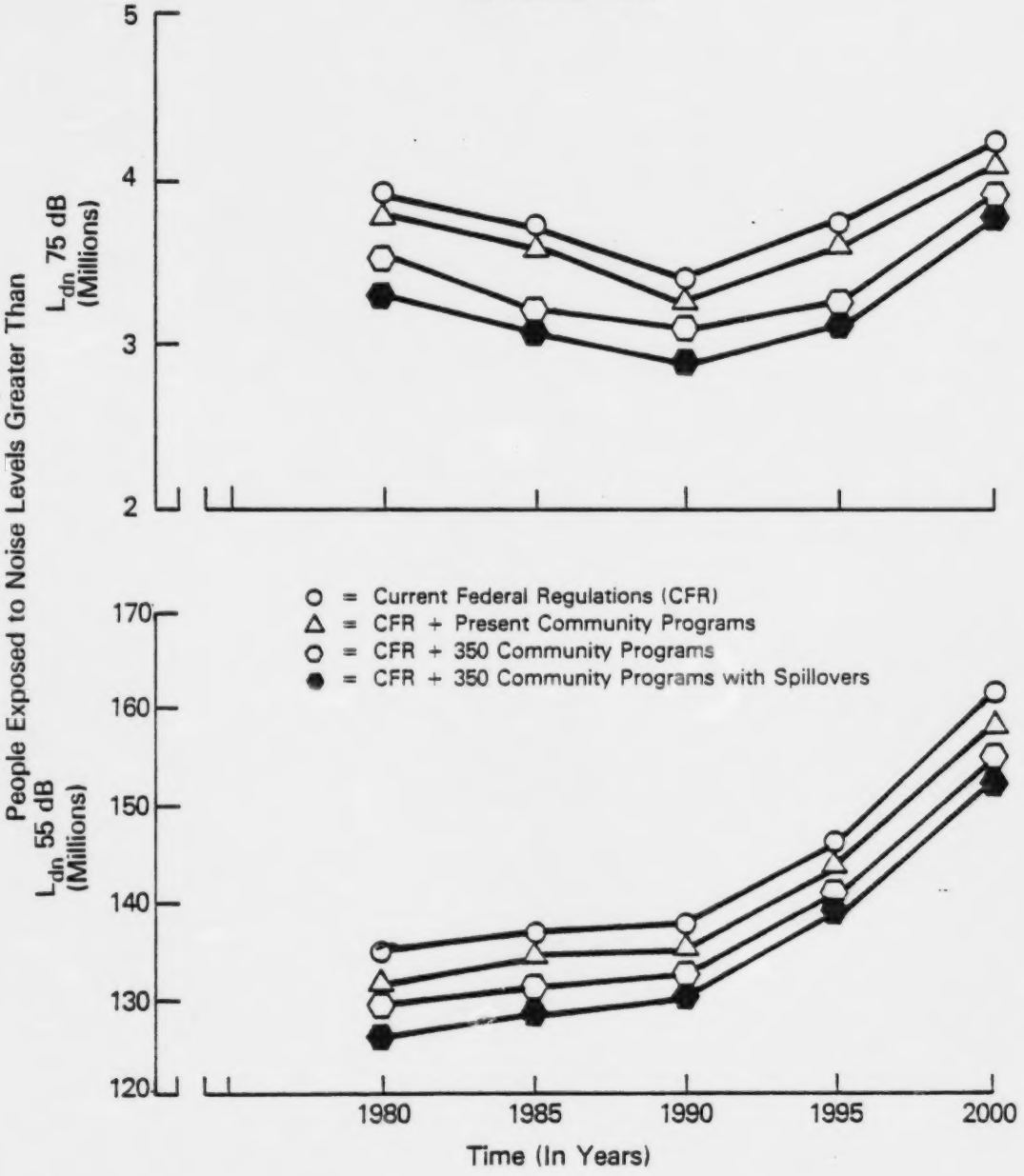
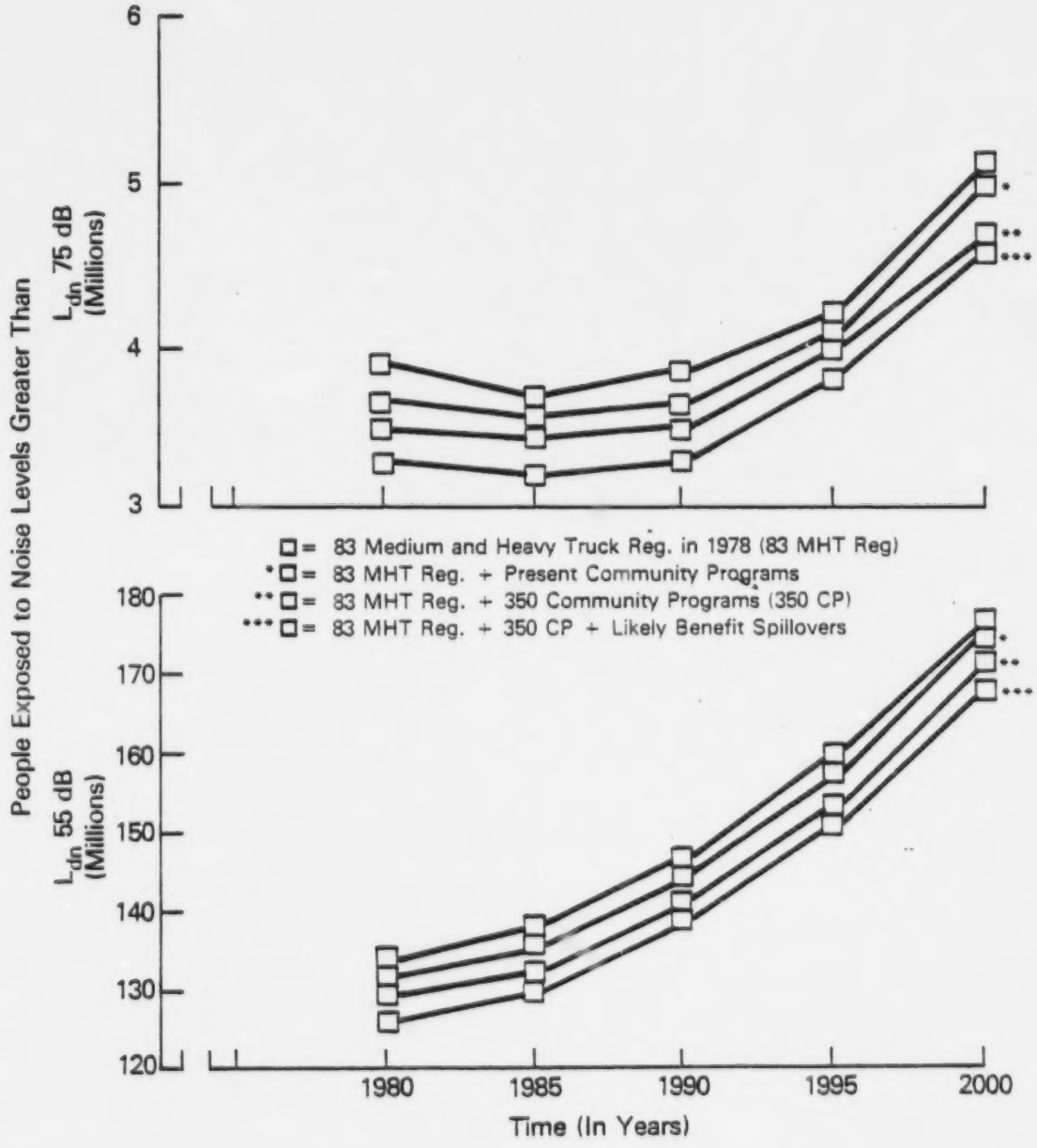
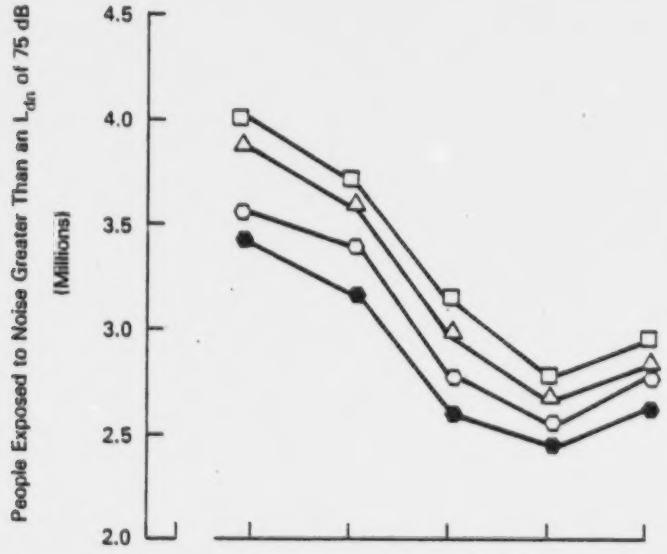


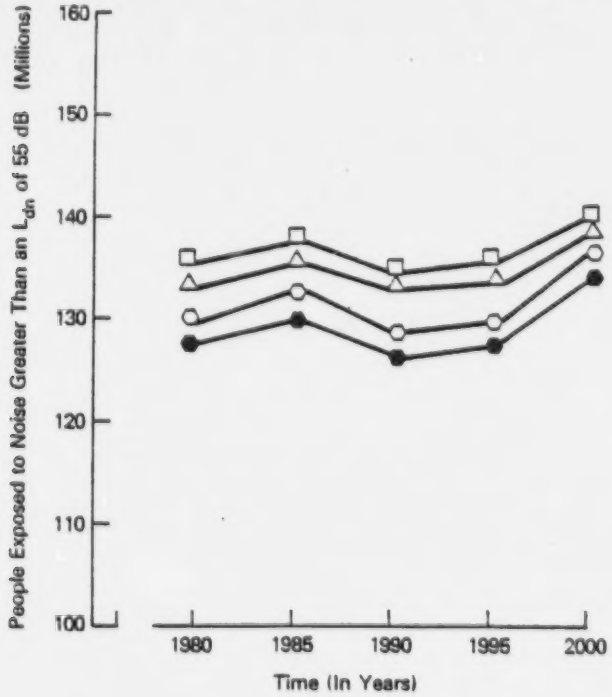
Exhibit III-3
Projected Exposures to L_{dn} Greater than 75 dB and 55 dB, Assuming an 83 dB Medium and Heavy Truck Regulation (Effective 1978) Together with Various State and Local Enforcement Scenarios



(Exhibit III-4)
Projected Exposures to L_{dn} Greater than 75 dB and 55 dB With 75 dB MHT Regulation



□ = Current Federal Regulations + 75 dB MHT Reg. (1990)
△ = CFR + Present Community Programs (PCP) + 75 dB MHT Reg.
⬡ = CFR + Planned Community Programs (350 PCP) + 75 dB MHT Reg.
⬢ = CFR + 75 dB MHT Reg. + 350 Planned Communities With Spillover Benefits



regulations (see Exhibit III-2 and III-3 for enforcement benefits in conjunction with the regulations as planned and promulgated by November 1, 1981 and with only the 83 dB MHT regulation, respectively).

C. BENEFITS FROM A STRICTER TRUCK REGULATION WITH ENFORCEMENT PROGRAMS

If a 75 dB MHT regulation were promulgated, given that the currently proposed and promulgated regulations were in force, noise exposures would fall significantly below expected 1980 levels without regulations. Active exhaust noise enforcement programs would lower the exposures further, especially with spillover assumptions. Exhibit III-4 shows the impact of the regulations (for comparison Exhibit III-2 presents (1) baseline exposure results without regulations; (2) with regulations as promulgated and planned; and (3) with only an 83 dB MHT regulation in 1978).

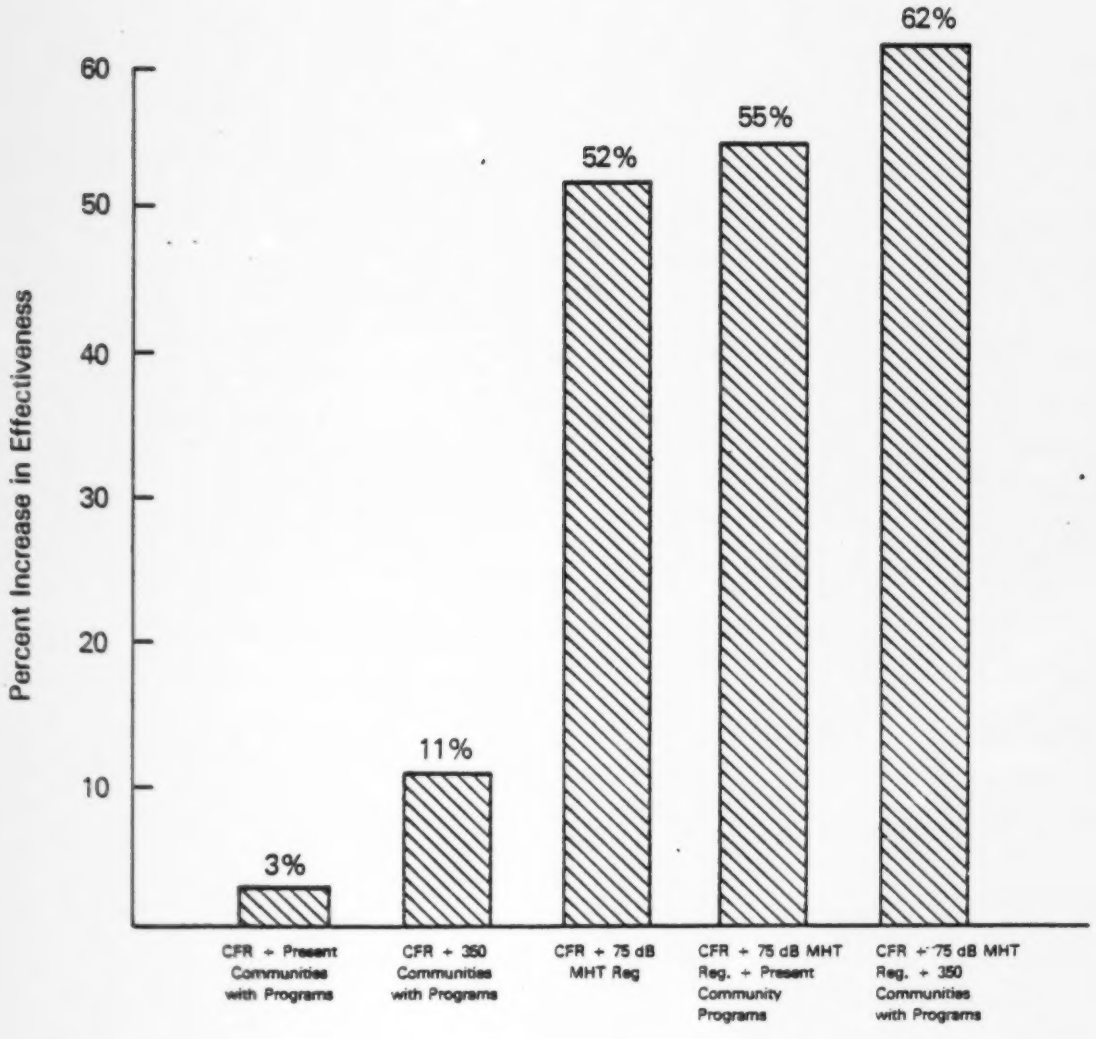
D. TIME-STREAMED ANALYSIS OF BENEFITS

One of the advantages of local enforcement programs is that they can be implemented relatively quickly with benefit accruing almost immediately. If we add annual benefits using the LWP descriptor, the relative benefits from active enforcement programs relative to benefits from regulations become larger. The benefits from regulations, in absolute terms, remain larger, however.

Using the benefits from the promulgated and proposed regulations as a base it was determined that the benefits would increase 3% and 11% if the regulations were augmented by the communities with noise programs now and with the 350 planned communities, respectively (see Exhibit III-5). If the 75 dB MHT

(Exhibit III-5)

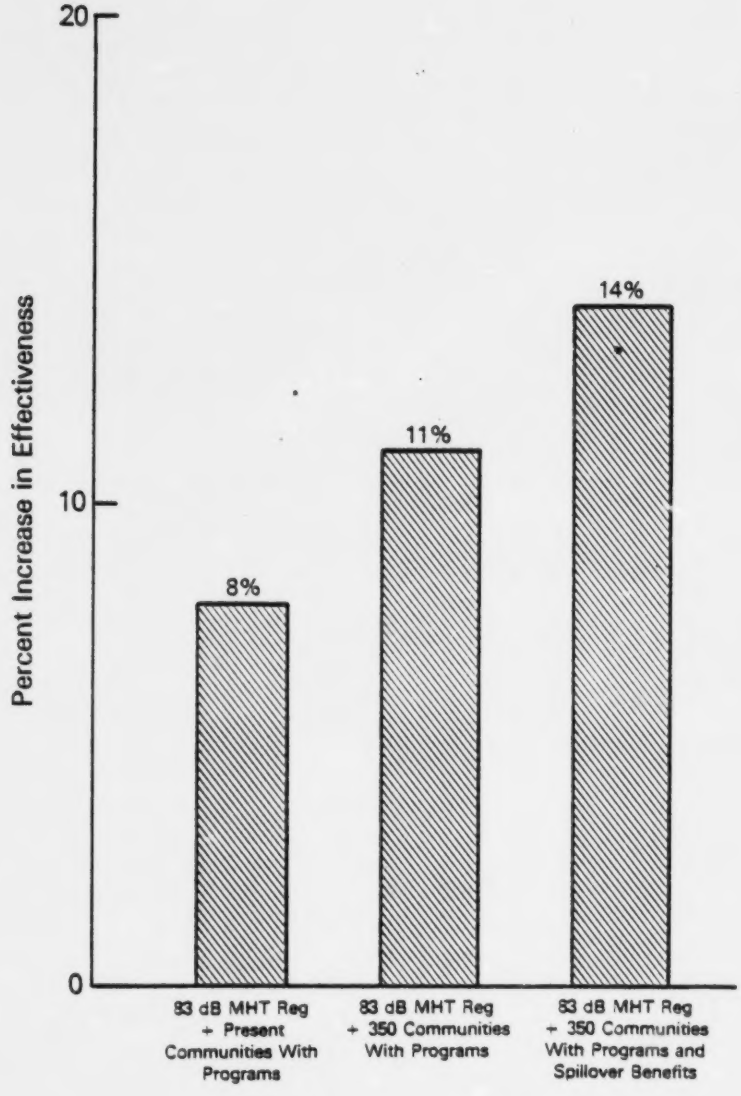
Percent Increase in Effectiveness of Various Controls (Effectiveness of Current and Proposed Federal Regulations = Base)



regulation (effective 1988) were combined with 350 community programs the benefits would rise 62% above the base during the 1980-2000 time period (see Exhibit III-5).

Spillover benefits would, of course, enhance the effectiveness of local enforcment programs. For example, if only the 83 MHT regulation were in existence, i.e., the first phase of the MHT regulation, 350 communities with enforcement programs would increase the effectiveness by 14% over the 1980-2000 time periods (see Exhibit III-6).

Exhibit III-6
Percent Increase in Effectiveness Due to Various Levels of State and Local Government Exhaust Noise Enforcement (Effectiveness of 83 dB Medium and Heavy Truck Regulation = Base)


20
10
0
Percent Increase in Effectiveness
8%
11%
14%
83 dB MHT Reg + Present Communities With Programs
83 dB MHT Reg + 350 Communities With Programs
83 dB MHT Reg + 350 Communities With Programs and Spillover Benefits

IV. COSTS OF REGULATIONS AND LOCAL ENFORCEMENT PROGRAMS

A. PURPOSE AND SCOPE

The intent of the cost discussion is to present a cursory look at the magnitude of costs associated with several major methods of dealing with national and local noise problems eminated from motor vehicles. The discussion will concentrate on:

(1) Costs of various federal regulation options,

(2) Costs of a range of local enforcement options, and

(3) The costs of spillover benefits

On the outset it must be made clear that this is one of the first attempts to look at costs this broadly. There are many reasons why further refinement in the future are absolutely essential. Among them are:

(1) Projected regulation costs have not undergone post-promulgation verification

(2) Regarding local enforcement costs

(a) data are not random;
(b) there is a general lack of temporal cost analysis; and
(c) the data are incomplete

These shortcomings not withstanding, the overall magnitude of the cost will be assessed.

B. COSTS OF VARIOUS FEDERAL REGULATION OPTIONS

Promulgated and Planned Regulation

The medium and heavy truck regulation, as promulgated, is estimated to cost about $3.6 billion between now and Year 2000 (present value of annual cost, discounted at 10%). The equivalent annual cost would be about $362 million. Combining this regulation with the planned motorcycle and bus regulations would raise the costs to $4.9 billion and $499 million, respectively.

First Phase MHT Regulation and Planned Regulation

If the stricter second phase of the medium and heavy truck regulation were not to become effective (only an 83 dB regulation), the costs between now and Year 2000 would amount to about $2.5 billion, or $249 million when annualized. This limited regulation combined with the planned motorcycle and bus regulations is estimated to cost $3.8 billion and $386 million, respectively.

Promulgated and Planned Regulations and 75 dB MHT Regulations

If the medium and heavy truck regulation were to become stricter, rather than stop at the 80 dB second stage, costs would be expected to rise. A 75 dB medium and heavy truck regulation effective in 1988, when added to the regulation as promulgated, would increase the cost of the truck regulation between now and Year 2000 to $5.3 billion and an equivalent annual cost of $534 million. Together with the planned motorcycle and bus regulation the costs are estimated at $6.6 billion and $671 million, respectively.

Exhibit IV-1 summarizes the above findings.

Exhibit IV-1

COSTS OF VARIOUS REGULATORY SCENARIOS

Regulatory Option	Cost* in Millions 1978 Dollars (1980-2000)	Equivalent Annual Cost in Million 1978 Dollars
Medium and Heavy Truck Regulation (MHT Reg.) as Promulgated	$3,600	$362
MHT Reg. Plus Motorcycle and Bus Regulation	4,900	499
83 dB MHT Reg. (only)	2,500	249
83 dB MHT Reg. with Motorcycle and Bus Reg.	3,800	386
MHT Reg. as Promulgated plus a 75 dB MHT Reg. in 1988	5,300	534
MHT Reg. Plus 75 dB MHT Reg. plus Motorcycle and Bus Reg.	6,600	671

*Present value of annual costs, discounted at 10%.

C. COSTS OF RANGE OF ENFORCEMENT OPTIONS

Because of the limited amount of suitable cost data for local government enforcement of exhaust noise programs, a range was established, consisting of the following low, medium, and high estimates.

Estimation Methodology (Low Cost)

Basic Assumptions

The low estimate was derived by making a set of hypothetical calculations. For simplicity several assumptions were made. The principal ones were as follows:

1. Off-road vehicles such as dirt track motorcycles, dune buggies, and snowmobiles are excluded. Data on off-road vehicles are scarce and inconsistent.

2. All vehicles subject to motor vehicle registration are considered, even though in some communities agricultural and some other classes of vehicles are exempt from the muffler provisions.

3. Motor vehicles are classified as trucks, cars, and motorcycles. vans, pickup trucks, and other vehicles weighing less than 6,000 pounds are classed as cars. Buses are ignored because a) their absolute numbers are small and b) the overwhelming majority of them are school buses which are, on average, very well maintained.

4. All communities are assumed to have distributions of vehicles per person equal to the national averages. No local circumstances or differences are taken into account. All communities are assumed to have the same legal authority, the same geographic relationships to their neighbors, the same climates, and so forth.

5. For each vehicle class a single average value is assumed for the reduction of noise that results from fitting the vehicles with a proper muffler.

Commonly Used Enforcement Techniques

From this experience it was found that the following enforcement methods are the most commonly used by States and communities:

1. Two-Man Teams Enforcing Under an Ordinance Which Requires the Observer of Violation to Write the Citation.

This method is used by the Florida Highway Patrol. The microphone of the sound level meter is set up on a tripod beside the road, and the two officers read the meter and give chase. In Florida the officer who issues the citation must observe the violation of the limit on the sound level meter. Therefore, the offender has passed the chase officer by the time he knows that a violation has occurred. The time and risk involved in the chase, plus the likelihood of losing the violator (especially if it is a motorcycle) make it impractical and uneconomical to monitor vehicle noise on high speed roads.

2. Two-Man Teams Enforcing Under an Ordinance that Encourages High Speed Surveillance.

The Maryland State noise law permits the officer who issues the citation (the chase officer) to do so on the direction of an officer trained in noise enforcement who actually observed the violation on a sound level meter. This allows the chase officer to be stationed further up the road, to be in radio contact, and to be able to flag down a vehicle travelling at high speeds, oftentimes simply by waving it over.

3. Single Officer Enforcing with a Meter

Even under programs basically designed for team enforcement, officers will often work alone for a variety of reasons. The Florida Highway Patrol uses this method part of the time. When they do, the techniques of enforcement must change. One officer working alone is a very common method and is analogous to most patrol situations. The single officer must give chase to the violator

after detection, so he must find surveillance locations with easy access to the highway and yet with adequate screening from on-coming traffic so as not to give advance warning of surveillance. He must have a way of mounting the microphone on the outside of his patrol car and the sound level meter on the inside. In a few jurisdictions the meter and microphone are mounted on a motorcycle, which is a very effective chase vehicle in heavy traffic.

4. Single Officer Using Radar and A Sound Meter Together

Using one officer for two assignments--radar speed limit enforcement and noise limit surveillance--is a method currently in use by several jurisdictions in the Midwest. It has been promoted as a cost-effective use of manpower by EPA's Region V. Although the method was developed to enforce noise level limits for light vehicles and motorcyles on roads with speed limits of 35 MPH or less, in principle it is applicable to other situations. The officer selects a surveillance location suitable for both speed and noise enforcement and prepares to cite either type of violator as the traffic dictates. The microphone is mounted on the outside of the chase vehicle and is connected to a sound level meter with an audible alarm when a threshold level is exceeded. The officer sets the threshold in the meter at the noise level limit for a particular class of vehicle in the appropriate speed zone. He then monitors the speed of passing vehicles with his radar equipment until a noise violator passes and triggers the alarm. The peak reading of the sound level meter is held by the instrument, so the officer can decide whether he can identify the single violator and whether he wishes to give chase.

The advantage of this scheme is its flexibility in allowing the officer to address whichever problems (noise or speed) are more pressing during a given period of enforcement. This method would be very useful after a noise program has been in effect for years and the number of violations has declined substantially.

5. Single Officer Without a Sound Level Meter

The greatest coverage can be enjoyed if each officer on the force enforces noise violations as a part of his normal patrol activites. The Maryland State Police are studying a plan to convert to this system. Each officer would receive some training for noise enforcement, but would cite violators by aural screening. The citation will require the violator to repair or replace the defective muffler and then to take the vehicle to a State licensed inspection station to obtain a verification of compliance. This approach has two weaknesses that must be controlled--that officers not assigned solely to noise will fail to actively enforce because of the plethora of other police duties, and that the public and the police officers themselves will distrust the ear alone as the measure of sound level violations.

Cost Calculations

Salaries

The two primary assumptions for the cost calculations resolved around the salaries and benefits of enforcement personnel and equipment. For purposes of this analysis, we shall use $8/hr. ($16,640 yearly) plus 30 percent benefits, or $10.40/hr. as a standard salary for a patrolman.

Automobile and Noise Equipment

Cost estimates for automobiles and equipment used were made. Assuming that a new vehicle would be purchased for a new noise enforcement officer, first year costs would be something similar to the following:

First Year Costs

Automobile	$ 7,000	
Radio	1,300	
Noise Equipment	1,900	
Other	200	
TOTAL	$10,400	$10,400
Costs of operation - $.06/mile		
2,500 miles/mo. x 12 = 30,000/miles/yr.		
30,000 x $.06 = $1,800/yr.		1,800
		$12,200

Second and Fourth Year Costs

Maintenance on Noise Equipment:	
10% of initial cost/yr. (5-yr. life)	
$1,300	
1,900	
200	
$3,400 x 10% = $340	$ 340
Costs of Vehicle Operation	1,800
	$ 2,140

Third and Fifth Year Costs

New Automobile	$ 7,000
Maintenance on Equipment	340
Costs of Vehicle Operation	1,800
	$ 9,140

To standardize these costs to yearly figures that can be used as an average, the cost of equipment can be depreciated over its useful life.

Item	Maintenance Cost/Year	Cost/New	Years of Life	Depreciation Cost/Year	Total Cost/Year
Automobile	$1,800	$7,000	2	$3,250**	$5,050
Radio	130*	1,300	5	260	390
Noise Equip.	190*	1,900	5	380	570
Other	20	200	5	40	60
Yearly Costs	$2,140			$3,930	$6,070

*10 percent/year

**Assuming a $500 salvage value for the automobile and zero salvage for other equipment.

These annual costs are applicable to a car that is completely dedicated to the noise program. If the officer to whom the car is assigned divides his time between noise enforcement and other duties, only the annual cost of the noise measuring equipment should be fully allocated to the noise program. The other costs should be prorated with the other programs. If the car is used 24 hours daily by three different officers, only one of which is assigned to noise surveillance, some adjustment should be made. If the car is dedicated to the noise program, but does not travel 2,500 miles monthly (as in a small town) the maintenance and depreciation costs should be adjusted.

Number of Vehicles not in Compliance

It is assumed that, at the beginning of enforcement of the muffler laws, 7% of the cars and light trucks, 10% of the medium and heavy trucks, and 12% of the motorcycles have defective or modified mufflers or no mufflers at all.

Outside Multiplier

Noisy vehicles come from outside the community as well as inside. Enforcing officers must stop commuters, shoppers, and visitors in addition to residents if the community noise level is to be reduced significantly. We have assumed that half of the cars that are stopped are registered in the community

and the other half are registered elsewhere. There are wide variations in this fraction depending on the size of the community and the proximity of its neighbors, but it is an assumption that is frequently made in traffic noise calculations.

Numerical Synthesis

If the goal is to reduce the number of vehicles not in compliance by 90%, for every 100,000 vehicles, 90,000 will have to be brought into compliance, 30,000 through the issuance of citations and 60,000 through the combination of a voluntary compliance because of increased awareness and voluntary compliance through fear of receiving a citation. The outsider vehicle multiplier is 2, so 60,000 citations will have to be issued to bring 90,000 resident vehicles into compliance.

We assumed an average figure of six citations per hour of full time patrol by a highly motivated officer. Thus about 10,000 hours of noise enforcement patrol will be required to issue 60,000 citations. Experience in Florida indicates that a highway patrolman who is assigned to full time noise spends about 1,000 hours on patrol and the rest of his time on training, court appearance, leave, travel to the enforcement sites around the state, and miscellaneous duties. A municipal police officer may be able to open 1200-1300 hours on patrol.

It is unrealistic and uneconomical to assume that all the officers who enforce the noise laws will do so on a full-time, dedicated basis. The program of public awareness and information about noise control and abatement succeeds best when it is combined with noise law enforcement continuously, and over a significant period, probably several years, so that it becomes part of the style and way of life of the community. As the violating vehicles are brought into compliance, the fraction of the total vehicles that are violators

decreases and the noncomplying vehicles become harder to find. Therefore, each officer who is on patrol will find that a smaller fraction of his time actually is chargeable to the noise program. However, because we have assumed that he combines noise with other patrol programs, to which he allocates the time not spent on noise, the officer's charge per vehicle brought into compliance remains the same.

For a program that lasts several years, there will be changes in the fleet of vehicles. There is a gradual increase in the number of vehicles because of population growth, and there is a substantial change in the identify of the vehicles as new ones are bought and older ones fall into noncompliance. However, in the absence of the noise program, the fraction of the vehicles that is not in compliance will remain the same. For incorporated cities of more than 25,000 people in the period of 1970 to 1978, the first of these factors was about 0.3 percent per year or about a one percent increase over a three-year enforcement period. However, it is reasonable to assume that these are new, complying vehicles.

The major factor that increases the number of vehicles that have to be brought into compliance is the immigration of vehicles. Data are available on fractions of the public that move in and out of standard metropolitan statistiscal areas, counties, and states.[1]

From these data one can infer that about 21% of the population will move from one county to another during a three-year period. Thus, for every 100,000 vehicles that were not in compliance at the beginning of the period, about 21,000 will immigrate. The rate of emigration would be equal, but is reduced

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[1] "Annual Housing Survey: 1977, Housing Characteristics of Recent Movers." U.S. Bureau of the Census.

by the fraction of compliance which is achieved before emigration occurs. A rough assumption is that the net effect is to increase the number of vehicles that need to be brought into compliance by 10%. If a balancing assumption of 1,100 hours per year of patrol per municipal police officer is made, the first calculation, that one person-year of effort is required to bring 9,000 resident vehicles into compliance, remains valid.

For 350 communities the total cost to bring 90% of the vehicles into compliance in three years is $7,105,000 or $6,767 per community per year. The cost per year per person is almost exactly $.05. For a 20-year period, with the above assumptions, the present value of annual costs is estimated at less than $8 million with an equivalent annual cost of around half a million dollars (see Exhibit IV-2).

Medium Estimate

The next estimate, referred to as medium estimate, was built up from information originating from answers in response to a National League of Cities (NLC) survey.

National League of Cities Survey Data

The NLC survey was sent to over 700 large and small cities in the United States. The criteria for being included in the sample survey was that small cities fall within the population range of 20,000 to 50,000, and large cities be in excess of 50,000. The questionnaire asks about the existing noise abatement control program, personnel and funds devoted to noise abatement, types of existing legislation, relative success of the program, operations in the last few years, etc.

The minimum population size for the sample of small cities was 20,999, with a maximum of 49,705, and an average of 32,248. In contrast, the sample survey of large cities had a minimum population of 50,104, a maximum of 7,481,613, and an average of 205,818.

Evaluation Criteria

In order to determine the aggregate cost of a national motor vehicle noise control program from the data supplied in the NLC sample survey, a number of adjustments to the basic data were made. These adjustments focus on those characteristics that apply to motor vehicle programs and include enforcement. Once the criteria were established and applied to the data series, summary statistics were calculated which facilitated the determination of national aggregate cost of noise abatement.

From the 700+ cities sampled by the National League of Cities (NLC), certain cities were selected for analysis based on the number of people exposed to an Ldn greater than 65 dB. The list of cities from which the choice was made corresponds to the Phase I effort of this project, i.e., the determination of benefits of a noise control program. In those cases where the cities identified were not included in the NLC survey, the next largest city (in terms of exposure) was chosen. All cities meet the basic criteria of population greater than 25,000. Once the 350 cities were selected, a number of additional selection criteria were applied to the sample. For example, only cities that had an existing enforcement program were chosen for further consideration. From that subsample only cities that had a motor vehicle code in existence were chosen for further evaluation.*/

Data Analysis

From the sample of 350 communities, 42 communities met the criteria. For the sample of 350 communities, population size ranged from 25,435 to 7,481,613 with a mean of 430,374 and medium of 92,520.

The range of expenditures for noise control was zero to $4,320,000. Average expenditures were $139,645 with standard deviations of $663,237. The median expenditure was $12,050.

*/ An attempt was made to distinguish between those communities which had a motor vehicle code and other existing noise control legislation, such as a municipal code, zoning code, land use restrictions, etc. However, the attempt to focus specifically on a motor vehicle code in a community where there was no other code was impossible. There were no cities that exclusively had a motor vehicle code. Therefore, it was necessary to choose communities that had a motor vehicle code without any additional restrictions on other types of noise control codes. The impact or potential bias of this selection criteria would be to attribute non-vehicle noise code expenditures and personnel allocations specifically to the motor vehicle code. That would tend to overestimate the resources required to establish a national noise control program for motor vehicles. Thus, the figures presented in the text should be taken to represent high estimates of the true cost of implementing a national motor vehicle standard.

Projecting the median expenditures in the same manner as was done in the preceding low cost exercise (which assumes that once a program is in existence and most vehicles are in compliance, the program can be phased down to merely maintain it), the total cost between now and Year 2000 is estimated to be around $14 million or about $1.4 million equivalent annual costs.

High Estimate

The high estimate was also based on the NLC survey. Instead of assuming a program phase-down once vehicles have been brought into compliance it was assumed that $139,645 average expenditures of the sample were incurred by 350 communities each year between now and Year 2000. Without accounting for inflation, the present value of these annual costs (discounted at 10%) is $465 million, annualized at $47 million (about $0.32 per person).

This estimate is high for many reasons, including but not limited to:

1. No phase-down was assumed after most vehicles have been brought into compliance

2. Enforcement costed out in this survey covered a variety of sources, not only exhaust noise

3. Costs were not prorated for personnel and equipment with multiple duties.

4. The sample is skewed in favor of large communities.

These shortcomings not outstanding, it is helpful to look at the range of costs.

D. THE COST OF SPILLOVER BENEFITS

Exhibit IV-2 presents a range of costs for 350 communities with vehicular noise programs designed to address at least noisy exhausts. These costs were calculated without geographic considerations. Geographic

distribution of these communities can, of course, affect the costs as well as the benefits. The combination with the largest benefit/cost ratio would require low cost programs per person covered combined with high spillover benefits. The spillover benefits accrue to the nation with essentially no additional costs.

Without national coordination, it is unlikely that the low cost combination will be achieved. In light of local government budget squeezes, it is most unlikely that funding for noise programs whose benefits accrue to a large extent outside the tax jurisdiction will assume a high priority. With national coordination significant spillover benefits can be realized without any one community bearing a grossly disproportionate share.

EXHIBIT IV-2

RANGE OF LOCAL ENFORCEMENT COSTS FOR 350 COMMUNITIES BETWEEN 1980 AND YEAR 2000+

	Total Cost* (1980 Dollars) Millions	Equivalent Annual Costs
Hypothetical Low Cost Option	7.7	0.6
Medium Cost Estimate Based on Median Expenditures of Surveyed Communities with Phase-Down Provision	13.6	1.4
High Cost Estimate Based on Average Sample Expenditures Without Phase-Down Provision	465.2	47.0

*Present value of annual costs, discounted at 10%.
+See assumptions for each cost option in preceding text.

E. SUMMARY COST REMARKS

The medium and heavy truck regulation program is the costliest program, followed by the motorcycle and bus regulations. There can be a large range of local enforcement expenditures, depending on the type of program and the assumptions made, but even on the high side of the range the costs are smaller that the regulatory options. It must be reiterated that the regulation cost projection should be verified empirically in the future and that an adequate local enforcement cost data base must be established to obtain better cost estimates.

V. SUMMARY AND CONCLUSIONS

This study indicates that without noise programs noise exposure to Ldn greater than 75 dB will more than double between 1980 and Year 2000, while the number of people exposed to Ldn 55 dB will increase by approximately 50%. The planned and promulgated federal regulations, i.e., various medium and heavy truck regulatory scenerios combined with the bus and motorcycle regulations, curtail this growth pattern significantly. With the help of local enforcement programs, even when only directed toward noisy exhausts, the exposure growth is further curtailed. In some instances it is even reversed.

Local enforcement programs by themselves also curtail noise exposure growth. With a noise program grid of 350 communities with populations over 25,000 a large number of people would be protected. In addition, it is expected that measurable spillover benefits--enforcement covering non-residents--add additional benefits.

Local programs can make an impact rather quickly, but, unlike regulations, they generally do not encourage the use of low-noise available technology. Therefore, while regulations and local programs can be exercised independently, the best results are obtained when used jointly.

The costs vary with benefits, although not proportionately. The proposed and planned regulations with or without a stricter 75 dB heavy truck regulation in the future cost the most, although the annualized costs of between $249 million and $671 million appears small in light of the large projected noise exposure reduction.

Compared to the range of regulatory costs the annualized costs for local programs amounting to $0.6 million to $47 million is indeed small. But then the expected reduction in exposure from vehicular noise is also less. The

benefits could be enhanced by establishing a coordinated national grid of communities with active programs. The costs would tend toward the low portion of the range if enforcement were to proceed in conjuction with other programs, like speed surveillance.

The essential conclusion is that the aforementioned programs yield substantial benefits and that the cost range is not large enough to prevent implementation of one of the programs or all of them. The programs can be instituted independently or jointly, and it is possible that local enforcement can be accelerated to offset delayed or eliminated regulations. If regulations should become tighter in the future, localities can re-evaluate their position. One program should never be perceived as a prerequisite of the other, because that would lead to inactivity, generally.